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## PATENT SPECIFICATION

DRAWINGS ATTACHED

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## COMPLETE SPECIFICATION

### Apparatus for the Continuous Longitudinal Stretching of Webs, or the Simultaneous Longitudinal and Lateral Stretching thereof

We, SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ N.V., a Company registered under the Laws of the Netherlands, of 30, Carel van Bylandtlaan, The Hague, The Netherlands, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to apparatus for the continuous longitudinal stretching of webs of a stretchable material, or simultaneous longitudinal and lateral stretching thereof.

It has been found that when certain stretchable materials, for instance certain thermoplastic materials, are stretched their strength increases in the direction of stretching. When the material is stretched in two mutually perpendicular directions the strength increases in both these directions. At the same time the material becomes thinner as a result of stretching. Stretching is advantageously applied to metal foils or to films, but it may also be carried out on other sheet materials in the form of a web, and the term web as used herein includes any long sheet of organic material.

In a known apparatus for continuously and simultaneously stretching webs in the longitudinal and lateral directions the edges of the web are gripped by grippers adapted to fan out simultaneously in the longitudinal and lateral directions, the grippers being located in grooves of a bar rotating about the longitudinal axis, which grooves are arranged along the periphery of the bar and are in the form of a screw having a pitch increasing towards the front. A drawback of this method is that the bars are difficult to manufacture and hence costly. A further drawback is that different

bars are required for each degree of stretch required.

When bars are arranged behind one another, particularly when they are not in alignment, difficulties occur as one bar has to take over the grippers from the preceding bar. Moreover, additional equipment is required for returning the grippers from the end of the bars to the beginning thereof.

An object of the present invention is to provide an apparatus for the continuous stretching of webs in a longitudinal direction, or simultaneously in a longitudinal and lateral direction, which is free from the above drawbacks.

According to one aspect of the present invention apparatus for the continuous longitudinal stretching of a web of stretchable material such as a film, or simultaneous longitudinal and lateral stretching thereof, comprises an endless movable chain arranged at the side of the path of the web, the chain comprising links which are mutually hingedly connected, securing means for securing the adjacent edge of the web, the securing means being connected to hinge connections of the chain, and a pair of guide members inclined to each other and arranged on that side of the path of stretch, one guide member of the pair guiding the chain hinge connections to which the securing means are connected, and the other guide member of the pair guiding chain hinge connections without securing means over at least a part of the path traversed by the chain, whereby in operation the spacing between adjacent securing means of at least some of the securing means which are in engagement with the web increases as these securing means carry the web forwardly. The guide members may be inclined to the path of the web thereby to cause lateral stretching of

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the web, and the two guide members of the pair may be adjustably inclined to one another to permit adjustment of the longitudinal stretching of the web.

5 According to another aspect of the present invention the apparatus comprises an endless movable chain on each side of the path of longitudinal stretch, the chains comprising links of equal length that are mutually hinge-  
10 ably connected, grippers for gripping the adjacent edge of the web, connected to alternate hinge connections of each chain, and guide channels grouped in pairs on each side of the path of stretch, the guide channel of  
15 each pair nearest the path of stretch guiding the chain hinge connections to which the grippers are connected, and the other guide channel of the pair, which converges towards the first in the direction of travel of the web, guiding the chain hinge connections without  
20 grippers over at least a part of the path traversed by the chain being guided by this pair of guide channels, whereby in operation of the chains the spacing between adjacent grippers of at least some of the grippers which are in  
25 engagement with the web increases as these grippers carry the web forwardly.

Preferably the apparatus is designed with pairs of guide channels arranged symmetrically to the path of stretch, and, viewed in the direction of forward travel of the web, the guide channels are arranged in divergent pairs so that the film is simultaneously stretched laterally as well as longitudinally.

35 According to a specific arrangement the apparatus comprises a flexible endless chain formed by a number of interconnected link groups, each group including links which are each interconnected by pins to adjacent links  
40 to permit relative pivoting of the links, securing means being provided to hold a side edge of the web to be stretched as it passes through the apparatus in a particular direction, such securing means being arranged at intercon-  
45 nections of the link groups, and a pair of guide members so arranged as to guide a succession of link groups adjacent that side edge of the web being passed through the apparatus thereby to move these link groups in a  
50 direction which is outwardly oblique with respect to the direction of movement of the web, the guide members being adjustably inclined to one another and also being inclined outwards with respect to the said direction  
55 of movement, one of the guide members being arranged to guide the points of interconnection of the link groups at which the securing means are arranged, and the other guide member being arranged to guide another point of  
60 interconnection of each link group, whereby in operation the spacing between adjacent securing means of at least some of the securing means which are in engagement with the web increases as these securing means carry  
65 the web forwardly.

An advantage of an apparatus according to the invention is that the degree of lateral stretch can be made adjustable within wide limits in a simple manner. Thus the pairs of guide channels may diverge in the direction  
70 of travel of the web, and the divergence can be adjusted to make the degree of lateral stretching adjustable. To provide adjustment of longitudinal stretching one guide channel of each pair may be adjustable relative to the  
75 other guide channel of the pair, to vary the convergence between the guide channels of each pair.

If guide channels are arranged parallel to the film a clamped film will not be stretched during forward travel. Additional pairs of guide channels arranged in this way may be located in juxtaposition in front of and/or behind each of the first mentioned pairs of  
80 guide channels, for example in order to facilitate heating or cooling before and after the film is stretched. In a cooling zone following the stretching zone the arrangement of guide channels parallel to the feed axis of the web may be used to prevent shrinkage of the stretched web. If in a heating zone the web  
85 tends to sag, the guide channels of a pair of guide channels may be so positioned that they slightly converge and the pairs of guide channels may be so positioned that they slightly diverge in the direction of travel of the web to take up any slack formed in the web by the heating.

The invention may be performed in various ways and a specific embodiment, and some modifications, will now be described by way of example with reference to the accom-  
100 panying drawings, in which:—

Figure 1 shows diagrammatically the principle on which the invention is based;

Figure 2 is a diagram of a preferred embodiment of an apparatus according to the invention;

Figure 3 shows a number of details of the embodiment of Figure 2;

Figure 4 is a diagram of a modified form of the details shown in Figure 3;

Figure 5 is a cross-section of one form of a pair of guide channels and chain of an apparatus according to the invention;

Figure 6 is a diagram showing another way of driving the chain in an apparatus according to Figure 2.

Referring to Figure 1, the circles denote hinge points 1a, 1b connected by links or bars 2 of equal length. The hinge points 1a, 1b are so distributed among guides a, b designated by chain lines that of each two successive hinge points 1a and 1b the first is capable of moving along guide a and the  
120 second along guide b. If the distance apart of the two guides a and b is everywhere the same the distance apart of each two successive hinge points 1a, or of each two successive hinge points 1b, will also be everywhere the  
125 130

same. This is clearly illustrated in the top part of Figure 1 in which, for example, the distance A—B is equal to A'—B'. If, however, the distance apart of two guides *a*, *b* is not everywhere the same but, for example, smaller at some region, the distance apart of two successive hinge points 1*a*, or of two successive hinge points 1*b*, will be greater. Thus in the bottom part of Figure 1, for example, the distance A'—B' is greater than the distance A—B. If the hinge points 1*a* and 1*b* move forward along the guides *a* and *b* between which the distance apart gradually decreases, then the distance between the same two successive hinge points 1*a* or 1*b* will also gradually increase.

This principle is employed in the invention for stretching a web of film. To this end the hinge points along one of the two guides, for example hinge points 1*b* along guide *b*, are provided with grippers which are capable of gripping the side of film which is to be stretched. When the guides are arranged in the manner shown in the bottom part of Figure 1, after the lapse of some time a part of the film clamped between points A and B, for example, will be located between A' and B' when the hinge points are moved in the direction shown, and will thus be stretched by a length equal to the difference between the distances A'—B' and A—B. The film can only be stretched in this way provided the guides *a*, *b* converge on each other in the direction of movement of the film. When the path of stretch, i.e. the path on which the clamped part of the film is located, remains the same, the degree of stretching depends on the angle of convergence  $\alpha$  between the guides *a* and *b*, i.e. the stretch increases with an increasing angle  $\alpha$ . The direction of stretch is the same as that of the guide along which move the hinge points which are provided with grippers, viz. the direction of the guide *b* in this example.

Let it now be assumed that the guides *a* and *b* with the links 2 and the hinge connections 1*a* and 1*b* are arranged in the manner shown in the bottom part of Figure 1 but in this case symmetrically on both sides of the film which is to be stretched, the film being clamped along the edges in grippers to the hinge connections 1*b* along the guides *b*. Since the stretch takes place in the direction of movement of the guides *b*, when the latter are arranged parallel to the film the latter will be stretched in a longitudinal direction only. By arranging the guides *b* so as to cause them to diverge in the direction of movement of the film, the film is also stretched laterally. This lateral stretching increases with an increasing angle between the guides *b*. When the guides *b* are arranged so as to diverge, the film is thereby simultaneously stretched in both the longitudinal and lateral directions. If both the guide channels *a* and

the guide channels *b* are arranged parallel to the film a film clamped in the manner described above will not be stretched either in the longitudinal or lateral direction but will merely travel forward with the hinge points 1*b*.

This latter arrangement may be applied in a cooling zone following the stretching zone to provide a cooling area while preventing shrinkage of the film due to cooling.

A preferred embodiment of an apparatus according to the invention is shown diagrammatically in Figure 2. A film 4 for stretching is taken from a stock roll 5, passes over a guide roll 6, and after having been stretched is wound on to a take-up roll 7 which is rotated by a drive roll 8. The roll 8 is rotated with such a speed that the film is not permanently stretched by the winding. Sometimes it is also possible to stretch the film immediately after it has been manufactured, for instance thermoplastic films on leaving the head of an extruder, in which case the stock roll 5 may be omitted.

On each side of the film 4 is a flexible endless chain 9 which is continuously driven by a drive wheel 10 rotating at a constant speed and a return wheel 11. The chains consist of links or bars 2 of equal length connected by hinge connections 1*a*, 1*b*. Successive hinge connections 1*b* are provided with grippers 12.

The hinge connections 1*a*, 1*b* of each chain 9 are led along the path of stretch by means of guide members or channels 13*a* and 13*b* arranged on each side of the film and symmetrically thereto in pairs so that all the hinge connections 1*b* provided with grippers 12 move along the guide channel 13*b* nearest the film, and all the hinge connections 1*a* without grippers move along the other guide channel 13*a*. In this way the loop of chain on each side is formed by a number of pairs or groups of links the two links of which have interconnected ends guided by the channel 13*a* and their other ends connected to adjacent pairs or groups of links by their interconnections which are guided by the channel 13*b*.

Viewed in the direction of forward travel of the film, a zone A, a zone B, and a zone C may be successively distinguished along the path of stretch in which the symmetrical guide channels 13*b* are respectively arranged parallel, divergent and parallel. The guide channel 13*a* of each pair of guide channels is arranged parallel to the guide channel 13*b*, in zone A, convergently in zone B, and parallel in zone C.

It is not essential for the paired guide channels to be located in a plane parallel to the film; the guide channels 13*a* may be in a higher or lower position than the corresponding guide channels 13*b* with respect to the

film without altering the stretching effect on the film.

The part of each chain in which no film is clamped may be conducted in the manner shown in Figure 3. In this case the guide channels of each pair issue in front of the drive wheel 10 into a common guide channel 13c where the chain assumes a stretched shape as a result of the tensile force exerted by the drive wheel. This stretched shape is maintained throughout the return journey of the chain until it leaves the return wheel 11. The hinges of the parts of the chain on a drive or return wheel are engaged by notches 14 and 15 respectively, arranged along the periphery of the wheel. After the chain has left the return wheel the hinge connections 1b and 1a are again distributed among the guide channels 13b and 13a respectively.

The hinge connections may be distributed, for example, by moving along a guide 16 (Figure 3) a lug or projection provided on each hinge connection 1b. The guide 16 is so designed that the hinge connection 1b provided with the lug is guided towards the corresponding guide channel 13b. As a result of the forces acting on the hinge connections 1a they move in the direction of the corresponding guide channel 13a. The hinge connections may also be separated in the reverse manner by providing each hinge connection 1a with a lug but not each hinge connection 1b, the said lug conducting the hinge connection 1a into the guide channel 13a over a guide, while hinge connections 1b move into the guide channel 13b. Other methods of distribution are also conceivable; all that is required is for any one type of hinge connection to be placed on the guide channel intended for this type.

Figure 5 is a cross-section of a preferred form of the guide channels, chains and hinge connections. The chain has links 2 connected to hinge pins 17 and 18. Each end of the hinge pin 17 is inserted in a ball-bearing 19 and 20 adapted to run inside the guide channel 13a.

The hinge pin 18 is inserted in one end of a ball-bearing 21 which is capable of running inside the guide channel 13b. The other end of the hinge pin 18 is provided with a gripper secured to the hinge pin 18 by means of a lock screw 22. The gripper 12 comprises a jaw 23 rotatable about a shaft 25 and co-operating with a fixed jaw 24. The jaws 23 and 24 are designed to be capable of gripping during stretching a film inserted between the jaws. The film may be clamped in the gripper or removed therefrom, by rotating the jaw 23 by means of a lug arranged at a given point along the guide channel in such a way that the jaws 23 and 24 are either moved towards or away from each other, as the case may be.

The apparatus shown in Figure 2 operates

as follows. A film 4, for instance a thermoplastic film, running off the stock roll 5 passes over the guide roll 6 and is clamped to the hinge connections 1b of the chains 9 at the points D in the grippers 12, the chains being driven by the wheels 10 rotating at a constant speed. The path of the film is divided into three zones A, B and C. In zone A the film is heated to the temperature required for stretching by means of hot air or liquid running along the surface of the film, or by radiation. Since the guide channels are arranged parallel to the film there is still no stretching in this zone.

In zone B the guide channels 13a and 13b are arranged in the manner described above, so that the grippers 12 of the hinge connections 1b moving along the guide channels 13b stretch the film, clamped along the sides, simultaneously in a longitudinal and lateral direction. In this zone B means are provided for keeping the film at a temperature appropriate to stretching.

In zone C the film is cooled while still clamped, so that the film is fixed in the stretched condition. In this way shrinkage of the film while being cooled is prevented, and subsequent shrinkage of the film after its release from the grippers is prevented or minimized, so that the dimensional stability of the stretched film during subsequent storage or use is increased. At the end of zone C these grippers are opened to release the film therefrom.

Knives 22 arranged on each side trim the rough edges of the film, after which the film is wound on the take-up roll 7 via guide wheels 23 at a constant speed adapted to the degree of stretch. A constant winding-up speed is obtained by pressing the drive roll 8, rotating at a constant speed, against the film on the take-up roll 7. It is, of course, also possible to subject the film to a further treatment immediately after stretching and cooling, or to use it, for example, immediately for packing purposes; in such cases the rolls 7, 8 may be omitted.

To permit various degrees of longitudinal stretching to be obtained the guide channels 13a, 13b of each pair are preferably designed so as to be mutually adjustable. It is also desirable for each pair of guide channels to be so adjustable as a pair that the degree of lateral stretching can be varied. Numerous combinations of longitudinal and lateral stretching are possible within wide limits, using the same chains, by making the guide channels adjustable both as a pair and with respect to each other. If the desired stretch exceeds these limits chains with longer links may be used.

In an apparatus which is provided with adjustable guide channels exchangeable or adjustable transition guide channels should be

provided in front of and/or after the adjustable guide channels.

As shown in the embodiment described, it is not necessary for the proper operation of the apparatus that the hinge connections of each chain should also be kept separate on the drive and return wheels and during the return of the chain. In this case, however, means such as those described above are required for the linear stretching of each chain before it passes over the drive wheel and for again separating the two types of hinge connections 1a, 1b after the chain leaves the return wheel.

Such means are not required when both types of hinge connections 1a, 1b are kept separate throughout the path traversed by the chain. This can be done in the manner shown in Figure 4 in which only the hinge connections 1b are arranged in recesses along the periphery of the drive or return wheel. The hinge connections 1a are led along a guide channel 26 which is concentric with the drive or return wheel. During the return of the chain the hinge connections 1a and 1b are kept separate by means of a guide channel 27 provided with a partition. In the top of Figure 4 is shown a cross-section of the guide channel 27 along the line A—A.

In order to reverse the direction of the chain at the end of the return journey it is not necessary to use a return wheel 11; as Figure 6 shows, curved guide channels 28a, 28b may be used for this purpose. These guide channels 28a, 28b are preferably designed with a gradually changing distance between each other so that when the chain leaves these guide channels it has already taken up the position required for clamping the film.

As shown diagrammatically in Figure 6, instead of or in addition to driving the chain 9 by means of a driving wheel 10, it may be driven by means of a separate, endless auxiliary chain 29 housed in zone A, next to the parallel guide channels 13a, 13b, and if necessary also in zone C. The auxiliary chain 29 is provided with projections 30 throughout its length. Along the part of the chain 9 between the guide channels 13a, 13b in zone A and C, a number of the projections 30 simultaneously push against lugs 31 on suitable links 2 of the chain 9.

The invention is not limited to rectilinear guide channels along the path of stretch; if desired, curved guide channels along such a path may be used.

It is also possible for the chains to be driven both by the wheels 10 and by the wheels 11.

#### WHAT WE CLAIM IS:—

1. Apparatus for the continuous longitudinal stretching of a web of stretchable material, such as a film, or simultaneous longitudinal and lateral stretching thereof, which com-

prises an endless movable chain arranged at the side of the path of the web, the chain comprising links which are mutually hingeably connected, securing means for securing the adjacent edge of the web, the securing means being connected to hinge connections of the chain, and a pair of guide members inclined to one another and arranged on that side of the path of stretch, one guide member of the pair guiding the chain hinge connections to which the securing means are connected, and the other guide member of the pair guiding chain hinge connections without securing means over at least a part of the path traversed by the chain, whereby in operation the spacing between adjacent securing means of at least some of the securing means which are in engagement with the web increases as these securing means carry the web forwardly.

2. Apparatus as claimed in Claim 1 wherein the guide members are inclined to the path of the web thereby to cause lateral stretching of the web, and the two guide members of the pair are adjustably inclined to one another to permit adjustment of the longitudinal stretching of the web.

3. Apparatus for the continuous longitudinal stretching of a web of a stretchable material such as a film or simultaneous longitudinal and lateral stretching thereof, which comprises an endless movable chain on each side of the path of longitudinal stretch, the chains comprising links of equal length that are mutually hingeably connected, grippers for gripping the adjacent edge of the web connected to alternate hinge connections of each chain, and guide channels, grouped in pairs on each side of the path of stretch, the guide channel of each pair nearest the path of stretch guiding the chain hinge connections to which the grippers are connected, and the other guide channel of the pair, which converges towards the first in the direction of travel of the web, guiding the chain hinge connections without grippers over at least a part of the path traversed by the chain being guided by this pair of guide channels, whereby in operation of the chains the spacing between adjacent grippers of at least some of the grippers which are in engagement with the web increases as these grippers carry the web forwardly.

4. Apparatus as claimed in Claim 3 wherein the guide channels are arranged symmetrically to the path of stretch and, viewed in the direction of forward travel of the web, the guide channels are arranged in divergent pairs to provide lateral stretching also.

5. Apparatus as claimed in Claim 3 or Claim 4 wherein the pairs of guide channels diverge in the direction of travel of the web, and the divergence can be adjusted to make the degree of lateral stretching adjustable.

6. Apparatus as claimed in any of Claims 3 to 5 wherein, in order to make the degree

of longitudinal stretching adjustable, one guide channel of each pair can be adjusted relative to the other guide channel of the pair, to vary the conveyance between the guide channels of each pair.

7. Apparatus as claimed in any of Claims 3 to 6 wherein in front of and/or behind each of the said pairs of guide channels there is provided an adjoining pair of additional guide channels, the guide channel of the latter pair nearest the path guiding the hinge connections which are provided with grippers and the other guide channel guiding the hinge connections without gripping devices, the additional guide channels all being parallel with one another.

8. Apparatus as claimed in any of Claims 3 to 7 wherein each chain is driven by means of a drive wheel and has a return wheel, the part of the chain on the drive wheel or return wheel being stretched in the form of a circular arch, and the part of the chain which is running back relative to the direction of forward travel of the web being rectilinearly stretched.

9. Apparatus as claimed in Claim 8 wherein before each chain moves along the path of stretch, the hinge connections provided with grippers are guided in a different path from the hinge connections without grippers by providing each of the former hinge connections with a lug which moves along a guide so shaped that the hinge connection connected to the lug is led to the guide channel intended for this hinge connection.

10. Apparatus as claimed in any of Claims 3 to 7 wherein each chain is driven by a driving wheel and has a return wheel and wherein, of the part of the chain on the driving wheel or the return wheel, the hinge connections provided with grippers are guided by a guide channel which is concentrically positioned relative to the corresponding wheel, while of the part of the chain which is running back relative to the direction of forward travel of the film the hinge connections provided with grippers are guided by one guide channel and the hinge connections without grippers are guided by another guide channel positioned parallel to the first.

11. Apparatus as claimed in any of Claims 8 to 10 wherein the return wheel is also driven.

12. Apparatus as claimed in Claim 7 wherein each chain is at least partly driven by at least one auxiliary chain positioned next to

a pair of parallel guide channels, which auxiliary chain is at several places simultaneously in contact with that part of the first mentioned chain which is being guided by the parallel guide channels.

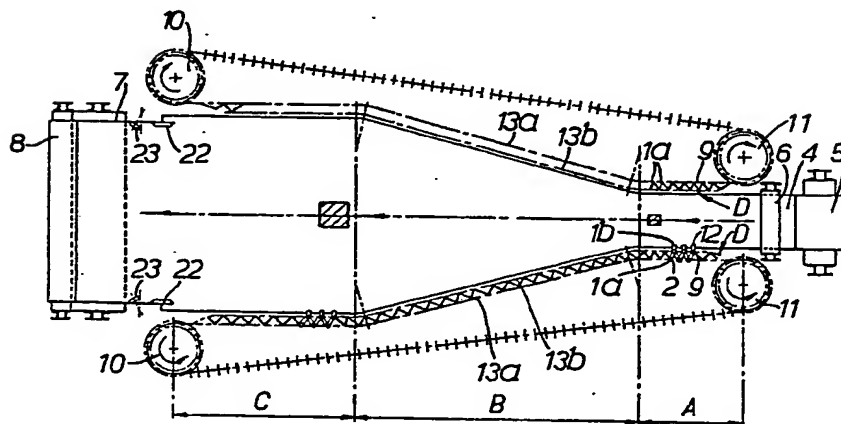
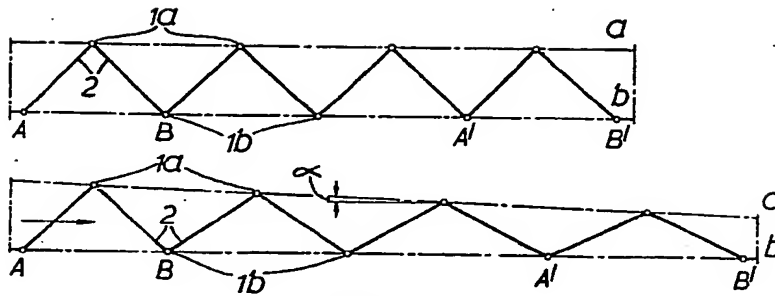
13. Apparatus for stretching a web of stretchable material such as a film comprising a flexible endless chain formed by a number of interconnected link groups, each group including links which are each interconnected by pins to adjacent links to permit relative pivoting of the links, securing means being provided to hold a side edge of the web to be stretched as it passes through the apparatus in a particular direction, such securing means being arranged at interconnections of the link groups, and a pair of guide members so arranged as to guide a succession of link groups adjacent that side edge of the web being passed through the apparatus thereby to move these link groups in a direction which is outwardly oblique with respect to the direction of movement of the web, the guide members being adjustably inclined to one another and also being inclined outwards with respect to the said direction of movement, one of the guide members being arranged to guide the points of interconnection of the link groups at which the securing means are arranged, and the other guide member being arranged to guide another point of interconnection of each link group, whereby in operation the spacing between adjacent securing means of at least some of the securing means which are in engagement with the web increases as these securing means carry the web forwardly.

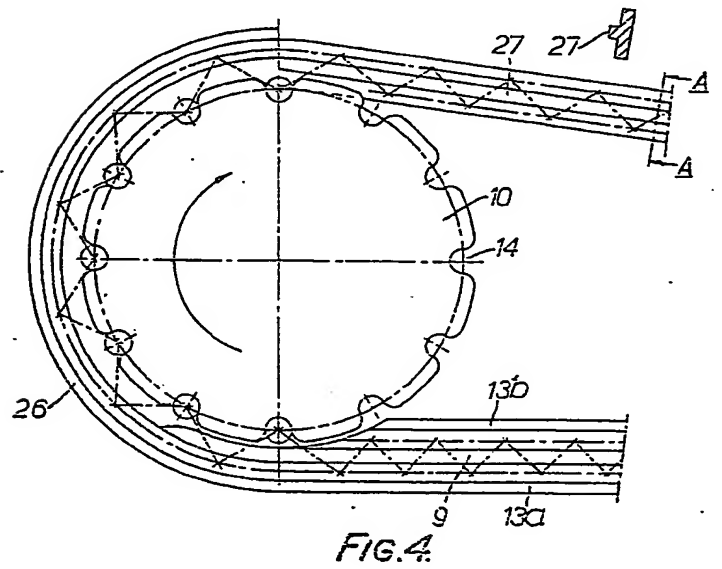
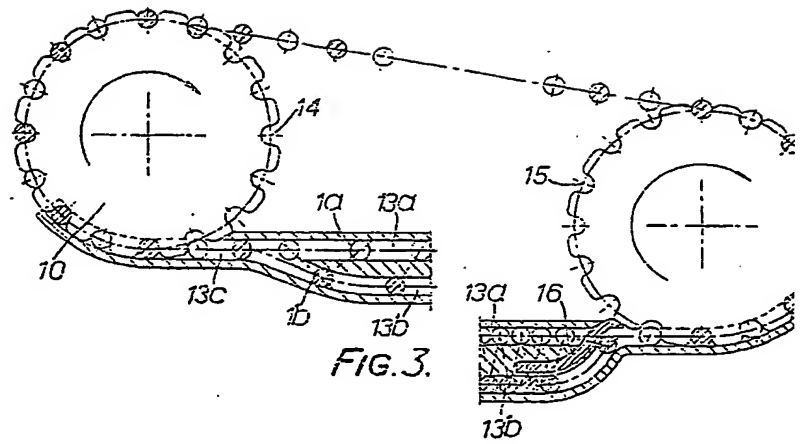
14. Apparatus for stretching film as claimed in Claim 13 wherein each pivotal connection is guided by a guide member.

15. Apparatus as claimed in Claim 13 or Claim 14 wherein the pair of guide members can be adjusted with respect to the direction of the web to vary the lateral stretching thereof.

16. Apparatus for the continuous longitudinal stretching of webs, or the simultaneous longitudinal and lateral stretching thereof, substantially as described with reference to Figure 2 of the accompanying drawings, or to Figure 2 as modified by any of Figures 3 to 6.

KILBURN & STRODE,  
Chartered Patent Agents,  
Agents for the Applicants.







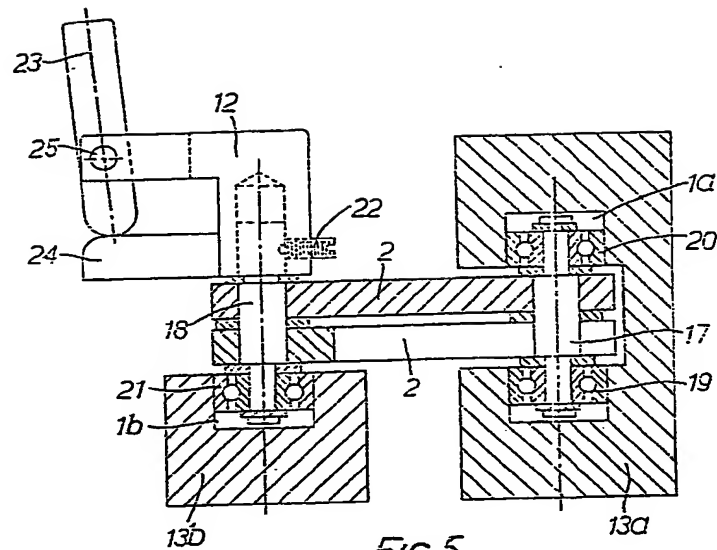
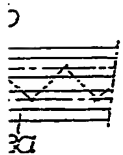
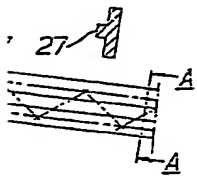
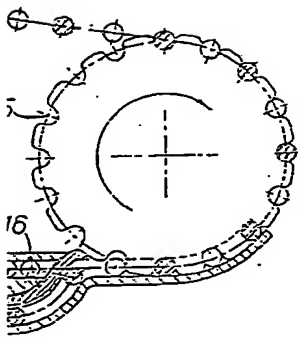


FIG. 5.

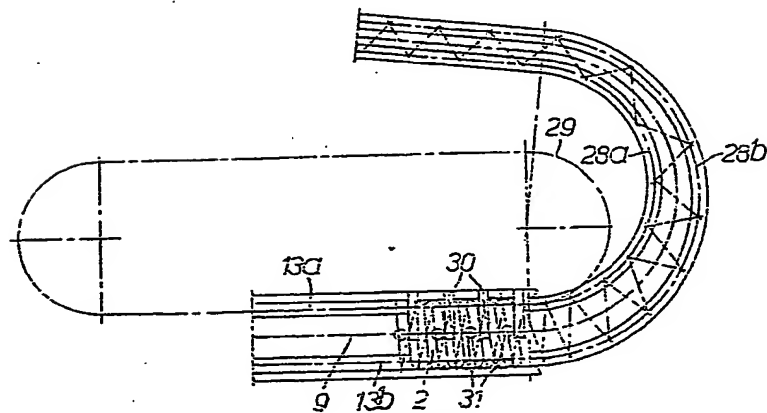
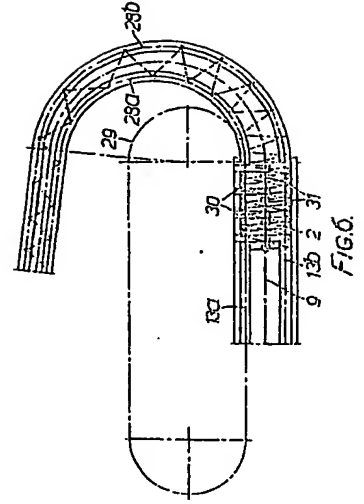
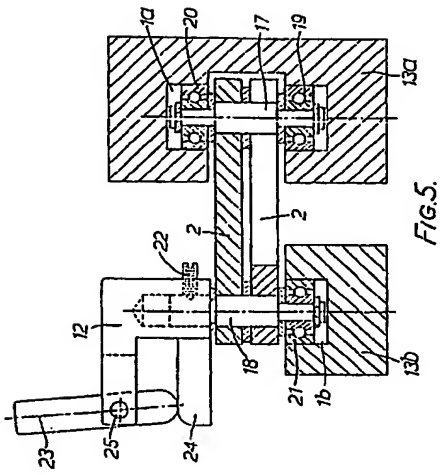
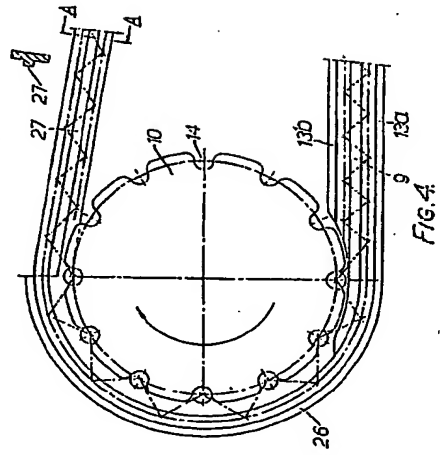
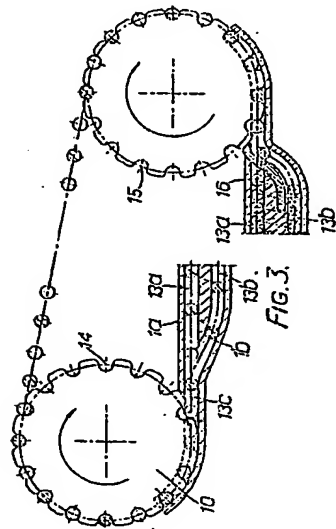


FIG. 6.



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